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CIA/BI GS 66-20
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VULNERABILITY OF SELECTED URBAN AREAS IN NORTH VIETNAM

I. Introduction

About 10 percent of the population of North Vietnam is urban. Slightly less than two-thirds of this urban population resides in the two largest cities, Hanoi (1961, estimated population, 650,000) and Haiphong (1961, estimated population, 375,000). The next 4 most populous cities, estimated as of 1961, are Thanh Hoa (80,000), Nam Dinh (70,000), Vinh (55,000), and Dong Hoi (55,000). These six cities and two centers of developing industry, Thai Nguyen (30,000) and Viet Tri (25,000), are the subject of this study (see Figure 1).

Selected target installations in the cities or their environs are located on accompanying 1:50,000 maps (Plates I through VIII), and descriptive data keyed to the installations appear on the map aprons.

Since many of the selected installations are located within relatively heavily built-up areas, inadvertant destruction of civilian residences and/or other nontarget buildings may occur in connection with air strikes. The degree of destruction from fire, whether spread by high explosive bombing or incendiary bombing, is generally related to: (1) the density of the buildings, or their "built-upness," a term used by the US Strategic Bombing Surveys on Japan,* and (2) the combustibility of material used in the construction of the buildings.

II. Density of Buildings

The degree of "built-upness" in various areas of Hanoi and Haiphong is shown in the Built-up Area Density maps on Plates I and II. Similar maps are unavailable for the other six urban areas, but radar-return maps which give some indication of the location and density of buildings have been substituted on Plates III through VIII.

On the Built-Up Area Density maps of Hanoi and Haiphong, the density is described in terms of roof coverage in three categories: (1) densely built-up (over 40 percent roof coverage), (2) moderately built-up (20 percent to 40 percent roof coverage), and (3) sparsely built-up (5 percent to 20 percent roof coverage).

Some concept of the extent of damage which may occur in the different zones of built-upness in Hanoi and Haiphong may be gained by a comparison with information in the US Strategic Bombing Surveys. Figures 2, 3, and 4 are based on detailed measurements in selected Japanese cities. Figure 2 shows the percentages of built-upness and areas occupied in square miles for various functional categories. Figure 3 shows the percentages of damage in different zones of built-upness by functional categories; Figure 4 is a graphic complement of Figure 3. The Japanese experience may be used as a very rough guideline to an estimate of possible damage to the residential areas of Hanoi and Haiphong. Validation and further refinement of the estimate require detailed consideration of any significant differences in construction materials or types of ordnance used. (Figures 5 through 8 allow some visual comparison of dwelling density and building types in Japanese and North Vietnamese cities.)

*A Report on Physical Damage in Japan, The US Strategic Bombing Survey, Physical Damage Division, June 1947.

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III. Conbustibility of Building Materials

The US Strategic Bombing Survey after analyzing Japanese building construction concluded that "only a few Japanese buildings were safe from fire and could effectively serve as area fire stops." A comparison of Japanese with Vietnamese construction indicates that the combustibility potential of Vietnamese buildings may be significantly less.

A. Japanese Buildings

The Bombing Survey describes the typical Japanese dwelling as one or two stories high with heavy wood sills and a wood or stone foundation without basement, 1-1/2 feet above ground level (see Figures 9 and 10). Wood frames were 4 by 4 inches and the rafters were often 4 by 6 inches. The roof was usually tile, set on mud-covered 1/2- to 2-inch wood sheathing over wood supports. Ceilings consisted of wide 1/4-inch wood boards loosely suspended on 2- by 2-inch supports. The floors were 1/2-inch boards covered by 2-inch rice-straw "tatami" mats except in hallways where 3/4-inch boards were used. Walls were made of bamboo laths thickly coated on both sides with natural-cement mud, and most exterior sides were weather-protected by a wide, 1/2-inch, unpainted lapboard. Interior partitions were either thin mud-bamboo, window frames with glass or paper, or thin panels of wood.

B. Vietnamese Buildings

Clay of excellent quality for making brick occurs in abundance near most of the urban areas in North Vietnam, and wood is relatively scarce. Brick is therefore probably the most widely used building material. Masonry construction, moreover, is dominant in at least the larger cities.* Because of this fact, it has been generalized that the danger of conflagration in the larger Vietnamese cities is not great.** It may be surmised, however, that the framing beams in the older houses are tinder-dry and would burn readily.

Buildings of masonry walls and tile roofs are most common in the French-built sections, which include administrative and cultural institutions and commercial and residential areas. The residences are typically detached, single-family dwellings situated in separate lots along broad, tree-shaded avenues, a condition which would minimize fire spread. Fire would be more likely to spread among the dwellings in the Chinese quarters of Hanoi and Haiphong which, although generally of masonry, are crowded together.

In contrast to these buildings, the traditional Vietnamese dwelling is a single-family, thatched-roofed structure of bamboo frame covered with plaster or bamboo mats (see Figures 11 and 12). It is highly inflammable. In Hanoi and Haiphong, such buildings are generally limited to small settlements in the outskirts. In the smaller cities, these thatched-roof huts are likely to occur also within the city proper, where they may be intermixed with masonry structures. Shacks made of corrugated iron and wood, as well as junks and sampans which line the canals in the Chinese quarter of Haiphong, are living quarters for thousands of inhabitants; these structures would be highly inflammable (see Figure 13).

* Most of the North Vietnamese urban areas, however, are built on deltaic alluvial soils, which will not support great weight without special engineering. Few buildings exceed 4 or 5 stories in height.

** NIS, North Vietnam, Section 25, Urban Areas, p. 25-2.

Masonry construction is common in the workers' housing built in recent years in the vicinity of industrial installations such as at Thai Nguyen (see Figure 14); in new apartments such as those on the southern limits of Hanoi (see Figure 15); and in the major new industrial installations,* in permanent army barracks, and in some large warehouses such as the steel-frame concrete warehouses located behind the Haiphong wharves.

IV. Functional Divisions

Vietnamese cities are more or less divided into functional divisions which may help to limit fire spread into residential zones, since selected targets are more likely to be grouped in nonresidential divisions (see Functional Divisions of Built-Up Areas on Plates I through VIII).

The distinct differences between functional divisions are most clear in Haiphong, where canals (which, in themselves, are firebreaks) partially delineate the six distinctive functional areas. The strip along the Cua Cam shoreline comprises the port area, including enterprises directly concerned with port activities. The central part of the city is composed of: (1) the commercial district and (2) the mixed residential and commercial division (the densely populated Chinese quarter) lying east of the bend of the Song (River) Tram Bac. South of the Chinese quarter is an almost exclusively residential division. The eastern and western parts of the city are industrial divisions.

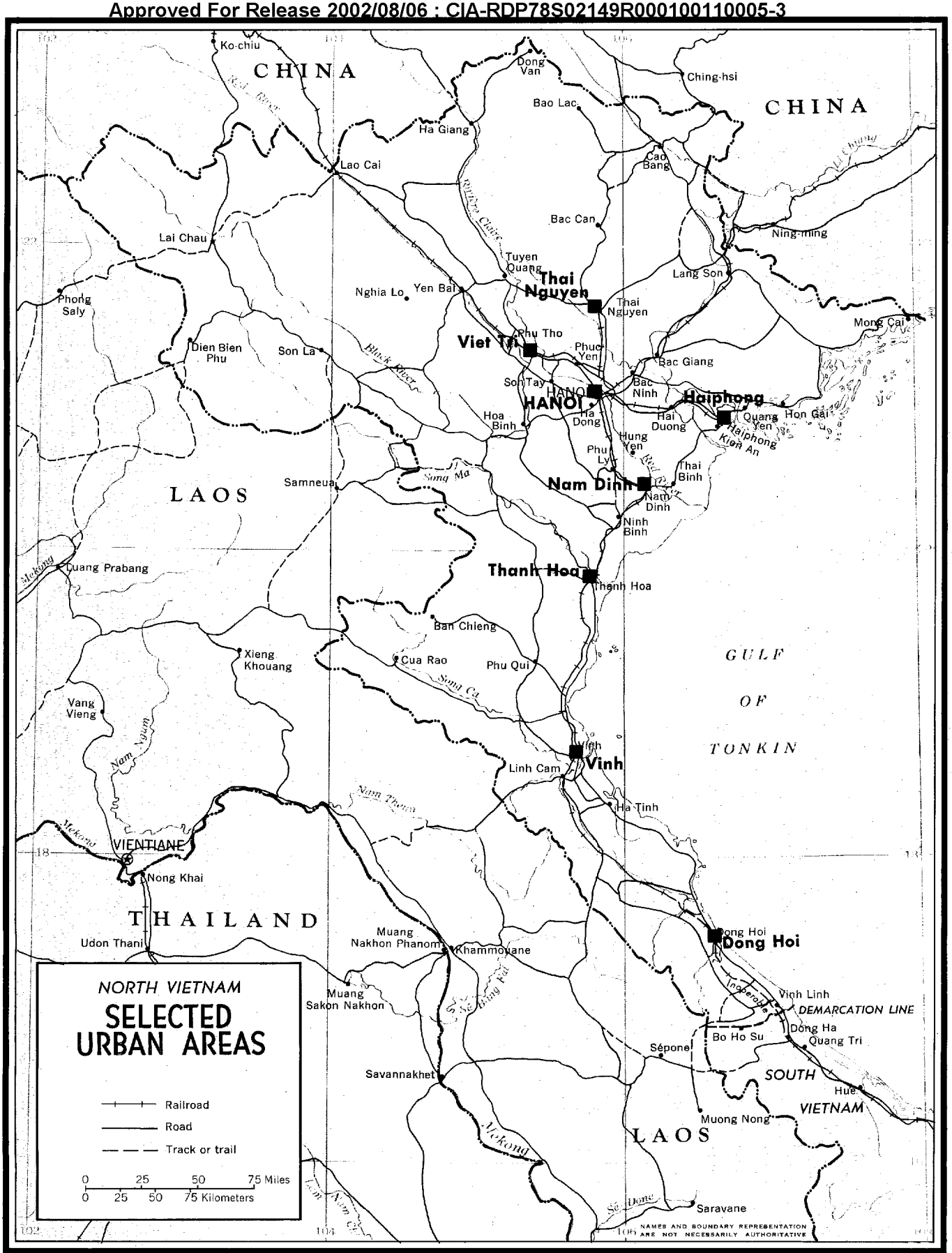
A large number of selected installations are located on the island which is bordered on the south and east by the Song Tram Bac (see Plate II). The main residential divisions are isolated from the island and would not be threatened by fire spread from it.

Hanoi is less clearly divided, although five main functional divisions are present (see Plate I). The north-central section contains the Citadel, a military area. The east-central and northwest sections (the latter being generally west of the Citadel) were developed by the French. Both are chiefly residential, with some mix of governmental and institutional buildings. The northeast and southeast sections are mainly mixed residential-commercial areas, the northeast section, bounded on the north and west by the railroad line, being the oldest and most densely built-up part of the city.

In Hanoi the selected installation most definitively isolated from residential divisions is Installation No. 4, the Ministry of Defense, located in the Citadel.

The location of installations with respect to functional divisions in the smaller urban areas can be ascertained by examination of the individual maps on Plates III through VIII.

*An article on Vietnamese architecture in the Chinese-language periodical, Chien-chu Hsueh-pao (Journal of Construction), No. 11, 1963, pp. 24-29, describes the main structure of new North Vietnamese industrial complexes as being made of reinforced concrete, prefabricated or poured on the site. The roof is generally flat, of reinforced concrete, and in some cases insulated against heat. Secondary buildings in the industrial complexes may be of brick and wood construction and generally have tile roofs.



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	Residential[1]		Residential[2]		Residential[3]		Mixed residential and industrial	
	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area
Akashi[4]		.23		.85		.11		
Amagasaki	43.0	.91	29.8	1.90	16.5	.30	28.8	.35
Kawasaki	45.0	2.26	31.8	3.69	16.7	5.80	31.0	.37
Kobe	49.2	5.79	30.3	3.34	16.3	6.81	50.0	.54
Nagasaki	44.0	.75	30.0	1.43	12.0	.98	33.0	.06
Nagoya	39.4	4.98	31.1	12.78	17.4	12.65	30.4	1.97
Nishinomiya	49.2	.47	30.3	5.32	16.3	3.99	50.0	1.11
Osaka	43.0	20.88	29.8	17.94	16.5	5.85	28.8	3.92
Tokyo	46.0	22.50	30.9	53.84	16.6	63.89	30.3	7.39
Yokohama	44.5	2.02	31.2	6.50	11.0	6.14	32.5	.46
Unweighted average	45.0		30.6		15.5		35.0	

	Manufacturing		Transportation		Storage		Total built-up area
	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area	
Akashi[4]							
Amagasaki	37.7	2.47	9.0	.05	37.8	.17	6.15
Kawasaki	43.4	5.19	14.9	.35	31.5	.59	18.25
Kobe	44.9	1.55	9.3	.70	53.6	.69	19.42
Nagasaki	46.0	.42	9.0	.04	29.0	.15	3.83
Nagoya	40.0	6.49	8.3	.22	42.6	.64	39.73
Nishinomiya	44.0	1.05	9.3	.06	53.6	.03	12.03
Osaka	37.7	10.43	9.0	.78	37.8	3.11	62.91
Tokyo	37.9	12.45	29.7	1.67	26.2	2.34	164.08
Yokohama	33.6	1.54	27.7	.20	27.5	.92	17.78
Unweighted average	40.6		14.0		37.6		

[1] Residential—Densely built up (40 percent and over).
[2] Residential—Moderately built up (20 to 40 percent).
[3] Residential—Sparsely built up (5 to 20 percent).
[4] Complete data not available.

Figure 2. Percentages of built-upness and areas occupied in square miles for certain Japanese cities.

City	Residential[1]	Residential[2]	Residential[3]	Manufacturing and residential	Manufacturing	Transportation	Storage
Akashi	92	37	88				
Amagasaki	29	11	0	39	12	0	0
Aomori	95	95	39				
Hachioji	100	90	19				
Kawasaki	79	51	9	69	19	12	33
Kobe	67	39	21	23	40	38	32
Nagoya	75	29	10	49	32	9	19
Osaka	53	8	8	20	18	8	18
Tokyo	76	40	40	33	17	10	21
Ube	56	42	4				
Yokohama	85	66	21	86	19	33	33
Unweighted average	73	46	23.5	45.5	22.5	15.5	22

[1] Residential Densely built up (40 percent and over).
[2] Residential Moderately built up (20 to 40 percent).
[3] Residential Sparsely built up (5 to 20 percent).

Figure 3. Percentages of damage in different zones of built-upness.

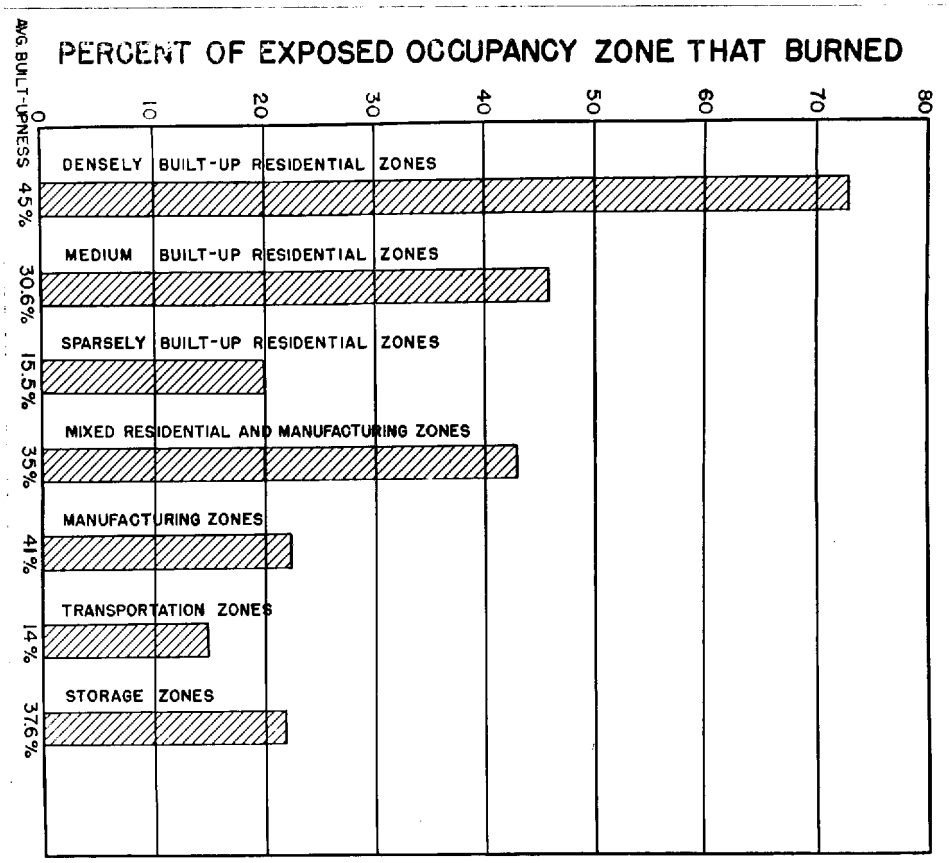
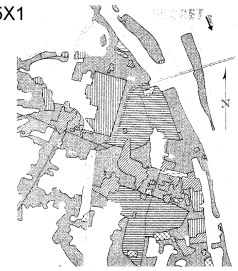
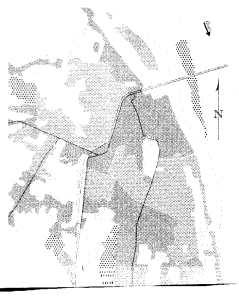


Figure 4. Graphically illustrates the data in Figures 2 and 3, showing the average percent of fire damage in 7 different functional zones.





Residential

Military

Industrial

Commercial

Governmental and institutional

Mixed residential and commercial

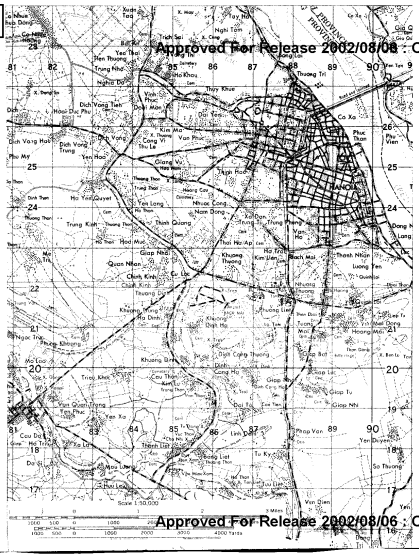
Densely built up (from 40% roof coverage)

Moderately built up (10% to 40% roof coverage)

Sparsely built up (5% to 20% roof coverage)

0 1000 2000 3000 4000 5000 Feet

0 200 600 900 1200 1500 Meters



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HANOI - SELECTED INSTALLATIONS

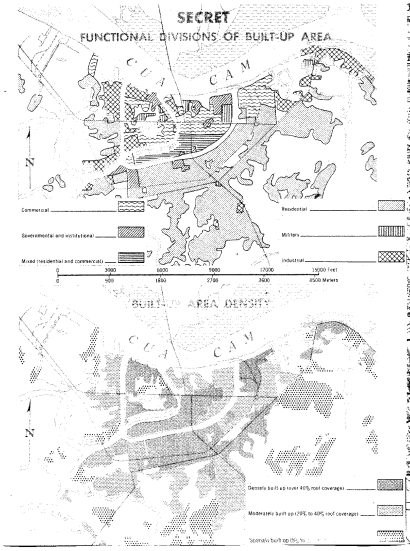
Map Scale 1:50,000

Map Number	Installation
1	Radio Intercept Research Section.
2	Hanoi Thermal Power Plant. Largest thermal power plant in North Vietnam. Only power plant in Hanoi. Capacity 32,500 kilowatts.
3	City Waterworks.
4	Ministry of Defense.
5	Ministry of Communications Offices.
6	Radio-Telegraph Office.
7	PTT (Post Office-Telephone-Telegraph) Building (ICC offices are adjacent to this building).
8	Hanoi Port Facilities Transshipment point for raw materials and finished products. Major traffic is barges and lighters; vessels exceeding 10.5 foot draft cannot approach this port. Estimated 12.5 acres of covered storage area.
9	Hanoi Railroad Yard Facilities include passenger station, freight terminal building, 2 car repair shops, 12 storage buildings, 15 miscellaneous buildings.
10	Alcohol Distillery.
11	Hanoi Machinery Works, Tran Hung Dao One of 2 largest engineering plants in North Vietnam.
12	Hanoi Storage Area Bac Mai Airfield 70 buildings.
13	Hanoi Army Barracks, Bac Mai Airfield Capacity 8,000 men. 110 buildings.
14	Hanoi Army Barracks, South Quinh Loi Capacity 16,000 men. 117 buildings.
15	Hanoi Army Supply Depot, South Quinh Loi 232 buildings. Significantly close to Hanoi/Bac Mai Airfield.
16	Hanoi Petroleum Products Storage Bac Mai Second largest POL storage area in Hanoi. Capacity 1,492,800 gallons.
17	Van Dien Motor Vehicle Storage and Repair Shops 60 buildings. Vehicles stored here can be quickly delivered to Hanoi military installations.
18	Van Dien Army Supply Depot One of largest storage complexes in North Vietnam. Storage capacity estimated 820,000 square feet. 291 buildings. Located astride the 2 principal lines of communication leading south from Hanoi.
19	Hanoi Motor Vehicle and Machine Tool Plant Largest machine building plant in North Vietnam, producing 50 percent of national output of machine tools.
20	Hanoi Rubber Products Plant Largest single rubber products plant in North Vietnam. Destruction would significantly reduce North Vietnam's production of automobile and cycle tires.
21	Hanoi/A/Army Barracks, West Yen Lang Capacity 9,500 men. 198 buildings.
22	Hanoi Radio Broadcasting Station Me Tri Contains transmitting facilities of Radio Hanoi; also main transmitting facilities of North Vietnamese Army point-to-point radio network. Located off map -- 3 miles WSW of Hanoi/Bac Mai Airfield.

Installations Not Included In Map Area

Hanoi Radio Transmission Station, Dai Mo
Principal point-to-point HF transmitting station in North Vietnam for domestic and international communications. Located off map -- 4 miles west of Hanoi/Bac Mai Airfield.

Hanoi Petroleum Products Storage, Thanh An
About 23 miles NE of Hanoi. Principal POL storage area supporting the Hanoi complex. Capacity 10,000,000 gallons.



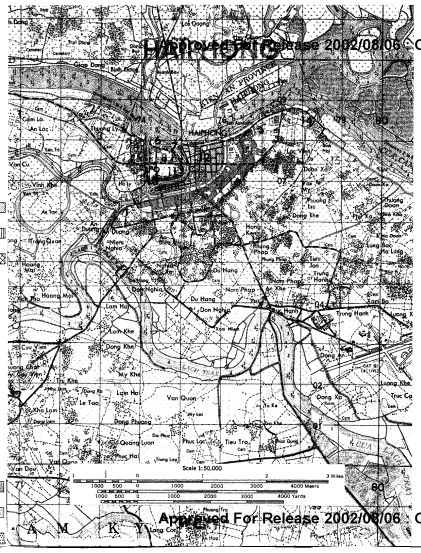


PLATE II

HAIPHONG - SELECTED INSTALLATIONS

Map Scale 1:50,000

Map Number	Installation
1	Haiphong Radio Communication Station International. Only reported international radio facilities other than Hanoi; probably would be depended upon for international defense and governmental communications in event of loss of the Hanoi capability.
2	Haiphong Petroleum Storage Area. Most important POL storage area in North Vietnam. Total POL storage capacity, 52,320,000 gallons. Destruction of installation would reduce North Vietnam's POL storage capability by 40%.
3	Haiphong Railroad Yard West. Probably a holding yard for rail tank cars. Destruction would severely hamper distribution of POL from adjacent tank farm.
4	Haiphong Cement Plant. One of largest Portland cement producers in SEA. Installed annual capacity 300,000 metric tons; effective annual production 300,000 metric tons. Communist China receives most of the exported cement.
5	Haiphong Thermal Power Plant (Cement Plant). Second largest power plant in the Tonkin area -- capacity 10,000 Kw. Supplies power to Haiphong Cement Plant and adjacent urban areas.
6	Haiphong Shipyard #1 Dancette. One of two main construction yards in Haiphong. (See installation No. 10) Has dock repair work on oceangoing vessels and dredges.
7	Haiphong Naval Basin. Primary naval base in North Vietnam; its destruction would hamper operating effectiveness of North Vietnam's short range coastal craft.
8	Barracks and Motor Pool.
9	Chemical Plant.
10	Haiphong Ship Repair Yard #1 Canonge One of the two main construction yards in Haiphong. (See installation No. 6). Has constructed 200 h.p. tugboats and does repair work on private and government boats.
11	Artillery Headquarters.
12	Military Headquarters.
13	Haiphong Port Facilities. Largest and most significant port in North Vietnam, handling 80% of the country's ocean shipping including about 85% of all imports (95% of the POL) and 70% of all exports.
14	Haiphong Thermal Power Plant. Capacity 6300 kw.
15	Haiphong Military Region Headquarters, Left Bank. Reportedly controls 170,000 troops of the Left Bank Military Zone which covers most of northeast North Vietnam. Area contains 34 buildings.
16	Haiphong Railroad Station Classification Yards and Shops. Main transshipment point for goods entering and leaving Haiphong and particularly for shipment to Hanoi. Destruction would seriously hamper movement of supplies and repair of locomotives and rolling stock.
17	Transmitter Station.

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Figure 5. Built-up area in Nagoya, Japan, showing fire resistant buildings interspersed among areas formerly occupied by combustible buildings.

Figure 6. Densely built-up Chinese quarter of Hanoi. Buildings are of masonry construction.

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Figure 7. Typical densely built-up area of small Japanese city.

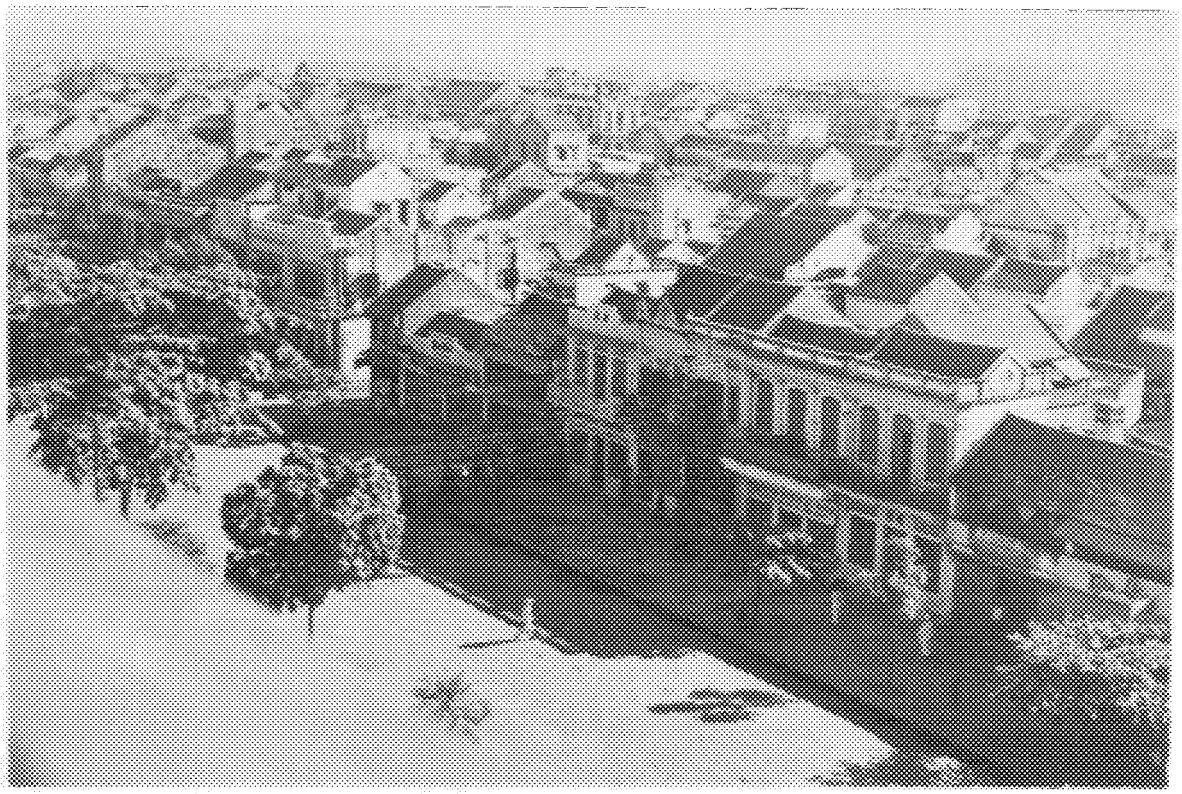

Figure 8. A view of Nam Dinh showing density and construction of buildings.

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Figure 9. Japan. Combination one- and two-story mercantile structures with dwelling occupancy on second floor. Unpainted wood siding usually covered mud-filled walls.

Figure 10. Japan. Typical dwelling in smaller Japanese city.

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Figure 11. Vietnamese dwellings near Thanh Hoa. The sides are of palm or bamboo mats and the roof is thatched. Such houses are generally on the outskirts of the larger cities but may be intermixed with masonry structures in the smaller urban centers.

Figure 12. Shows framework of typical thatched-roof Vietnamese dwelling in Vinh area. According to Soviet source of picture, house was being rebuilt after destruction by U.S. bombing.

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Figure 13. The Chinese quarter of Haiphong borders the Song (River) Tram Bac. Many of the junks and sampans serve as homes.

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25X1

Figure 14. Thai Nguyen. Cadre workers' apartments, of masonry construction.

Figure 15. New apartments, of masonry construction, on the southern outskirts of Hanoi.

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